



Influence of Foraging time, Flight activity patterns and Duration of a foraging trip of *Apis* species (order: Hymenoptera) on *Brassica campestris* var. Sarson

J.S. Tara and Pooja Sharma[#]

P.G. Department of Zoology, University of Jammu (J&K) 180 006

Dr. J.S. Tara, Department of Zoology, University of Jammu.

Ms. Pooja Sharma C/o Dr. J.S. Tara, Department of Zoology, University of Jammu, Jammu (J&K) 180 006.

(*email: puja80_sharma@yahoo.co.in)

Abstract

Foraging behaviour of *Apis cerana* and *Apis mellifera* was studied at two field stations- Pallimore and Hiranagar in district Kathua of Jammu region (J&K), in order to determine their potential for working hours in the fields of sarson. Single colonies of each species were placed in the fields till the end of flowering. Commencement of the foraging activity of *Apis cerana* (0624±0.91 and 0622±0.55 hrs) was significantly earlier ($P < 0.0001$) than *A. mellifera* (0648±0.68 and 0645±0.98 hrs) at both the fields respectively. However in the evening, *A. cerana* mean timings: 1842±0.84 and 1844±1.07 hrs, ceased its foraging activity significantly later ($P < 0.001$) than *A. mellifera* mean timings: 1813±1.06 and 1817±2.10 hrs respectively at both the fields. For flight activity patterns, *A. mellifera* reached its maxima (0800-1400 hrs) before *A. cerana* (1000-1200 hrs) at Pallimore, while at Hiranagar peak activity of *Apis cerana* lies between 1000-1300 hours and that of *A. mellifera* lies between 1000-1400 hours. Duration of foraging trip was significantly more ($P < 0.05$) in *A. mellifera* (24.14 minutes) than *A. cerana* (22.97 minutes) at Pallimore, but no significant differences ($P > 0.05$) were observed at Hiranagar for *A. cerana* (23.77 minutes) and *A. mellifera* (24.54 minutes).

Keywords: - *Apis mellifera*, *Apis cerana*, *Brassica campestris*, Foraging.

Introduction

Honeybees are the most efficient pollinators of cultivated crops because of their floral fidelity (Wells and Wells, 1983 & Waser, 1986), potential for long working hours (Sihag, 1990), presence of pollen baskets, maintainability of high population, micromanipulation of flowers and adaptability to different climatic conditions (Verma and

Partap, 1993).

The use of bees for pollination purpose is increasing day by day in different parts of the world. It is considered that the services that bees render to agriculture in the pollination of fruits, vegetables, legume and other seed crops are worth many times the return which beekeepers receive in the form of honey and

bee-wax.

Materials and Methods

Foraging behaviour of *Apis cerana* and *A. mellifera* species of honey bees were studied by placing single colony of each of these species in sarson crop, till the end of following.

Foraging time

Foraging time of *Apis cerana* and *A. mellifera* was assessed in terms of timing of commencement and cessation of flight activity and was observed by recording the time when the first bee started its flight in the morning and last bee ceased in the evening. This data was recorded for a period of seven days during the full bloom (Verma and Dulta, 1986; Verma and Partap, 1993 and Kumar, 1998).

Flight activity patterns

Flight activity was measured in terms of number of worker bees of *A. cerana* and *A. mellifera* leaving the hive per minute. These observations were recorded daily at regular hourly intervals from 0700 hrs. in the morning to 1800 hours in the evening. From the recorded data peak hours of foraging activity were calculated for both *A. cerana* and *A. mellifera* in terms of maximum number of foragers leaving the hive at particular hours (Kumar, 1998).

Temperature and relative humidity were also recorded at the time of taking bee counts in the crop fields. All these observations were taken for a period of 7 days in each field.

Duration of a foraging trip

Duration of a foraging trip was studied randomly by marking 20 worker bees each of *A. cerana* and *A. mellifera* with nail polish of different colours on their thoracic region. The interval between bees leaving and entering the hive was recorded with the help of a stop watch (Mattu, 1982). In total, 10 observations were

made daily during different hours of the day. These observations were repeated regularly for 7 days during the blooming period, in each study locations. The bees were regularly marked depending upon their casualties.

Results and Discussion

Foraging time

Bees moving out for the collection of nectar and pollens for their colony are called as the foragers. They forage for specific time of the day in the field. The data regarding the commencement and cessation of foraging time of *Apis cerana* and *A. mellifera* is presented in the Table 1. The mean timing of commencement of the foraging activity of the Indian hive bee, *Apis cerana* was 0624 ± 0.91 and 0622 ± 0.55 hrs, respectively at Pallimore and Hiranagar fields which was significantly earlier ($P < 0.001$) than the European hive bee, *A. mellifera* whose mean foraging activity starts at 0648 ± 0.68 hrs at Pallimore and 0645 ± 0.98 hrs at Hiranagar field. However in the evening, *A. cerana* mean timings: 1842 ± 0.84 and 1844 ± 1.7 hrs ceased its foraging activity significantly ($P < 0.001$) later than *A. mellifera* mean timings: 1813 ± 1.06 and 1817 ± 2.10 hrs, respectively at both the fields. Thus average duration of foraging activity lasted for 12.17 ± 0.22 and 12.21 ± 0.15 hrs for *A. cerana* & 11.64 ± 0.16 and 11.72 ± 0.18 hrs for *A. mellifera* respectively at both fields.

These observations are in conformation with the earlier reports of Kapoor and Dhaliwal (1989) on cauliflower at Hissar, Verma and Partap (1993) at Nepal for *B. juncea*. Verma and Partap (1993) also studies the foraging timing of *A. cerana* on cauliflower, cabbage, radish and lettuce at Nepal and concluded that it starts its foraging activity early in the morning and ceases late in the evening.

These differences in the mean timings of the commencement and cessation of foraging

activity may be due to differential interactions between genotype of the two species and the environment (Kumar, 1998).

Table-1: Commencement and cessation of foraging time of *Apis cerana* and *A. mellifera*.

Pallimore				Hiranagar			
Initiation		Cessation		Initiation		Cessation	
*A.c.	*A.m.	A.c.	A.m.	A.c.	A.m.	A.c.	A.m.
0624	0648	1842	1813	0622	0645	1844	1817
Duration (in hours)							
<i>A. cerana</i>		<i>A. mellifera</i>		<i>A. cerana</i>		<i>A. mellifera</i>	
12.18		11.65		12.21		11.72	

*A.c.= *Apis cerana*; *A.m. = *Apis mellifera*.

Flight activity patterns

Indian and European hive bees were monitored for their foraging activity patterns at regular hourly intervals from 0700- 1800 hrs at both the fields as shown in Tables 2 & 3 and figure 1 & 2. The flight activity patterns of *Apis cerana* and *A. mellifera* at Pallimore and

Hiranagar stations, presented in the tabulated form revealed *A. mellifera* reached its maxima (0800-1400 hours) before *A. cerana* (1000-1200 hours) at Pallimore while, the peak period of two species coincides at Hiranagar.

Parameters	Pallimore		Hiranagar	
	<i>A. cerana</i>	<i>A. mellifera</i>	<i>A. cerana</i>	<i>A. mellifera</i>
Peak activity(hrs)	1000-1200	0800-1400	1000-1300	1000-1400
Temperature (°C)	20.63-24.20	15.51-25.34	19.57-24.46	19.57 -
Relative humidity (%)	72.86-59.43	77.28-53.86	78.43-60.71	78.43-53.43

Mishra *et al.* (1988) observed peak foraging activity of *A. cerana* between 1300-1400 hrs on mustard bloom. Thakur *et al.* (1982) recorded peak foraging activity of *A. mellifera* and *A. cerana* at 1200 hrs and smaller peak activities between 1400 hrs and 1500 hrs on mustard bloom. Chand *et al.* (1994) during their studies reported maximum peak activity of *A. cerana indica* at 1500 hrs. and 1600 hrs. and that of *A. mellifera* at 1300 hrs. on *Brassica juncea*. Peak periods of *A. cerana* was recorded as 1200 hrs. -1400 hrs. on cauliflower in Solan, H.P., by Dhaliwal and Bhalla (1980). Maximum peak activity of Hymenopterans and Dipterans were recorded at 1400 hrs. by Priti and Sihag (1997) on cauliflower, Hissar.

These differences in foraging activity patterns of *A. cerana* and *A. mellifera* may be due to the difference in the genotype and

environmental interactions (Kumar, 1998).

Duration of a Foraging Trip

Foraging data on sarson crop showed that *A. cerana* spent on an average 22.97 ± 0.40 minutes and 23.77 ± 0.44 minutes for a single foraging trip at Pallimore and Hiranagar, whereas this duration was 24.14 ± 0.38 minutes and 24.54 ± 0.35 minutes for *A. mellifera* at both Pallimore and Hiranagar respectively.

Statistical analysis of the data revealed that duration of a foraging trip (interval between the number of bees leaving and entering the hive) was significantly ($P < 0.05$) more in *A. mellifera* than *A. cerana* at Pallimore. But no significant ($P > 0.05$) difference was observed between *A. cerana* and *A. mellifera* at Hiranagar shown in tabulated form as: -

Parameters	Pallimore			Hiranagar		
	<i>A.cerana</i> X±S.E	<i>A.mellifera</i> X±S.E		<i>A.cerana</i> X±S.E.	<i>A.mellifera</i> X±S.E	
Duration of a foraging trip (minute)	22.97±0.40	24.14±0.38	S	23.77±0.44	24.54±0.35	NS

X±S.E = Mean±Standard error about the mean; S = Significant ($P < 0.001$; 0.05); NS = Non-significant ($P > 0.05$)

These differences may be due to small size of the flower of *Brassica campestris* where *A. mellifera* spent more time in collecting nectar and pollens as compared to *A. cerana*. These results of the present author are in agreement with earlier findings of Verma and Partap (1993) who reported that duration of foraging trips of

A. mellifera (25.29 ± 0.57) was more than *A. cerana* (23.24 ± 0.22).

Verma and Partap (1993) also observed duration of foraging trips of *A. cerana* as 26.8 minutes on cauliflower, 23.8 minutes on cabbage, 22.1 minutes on radish and 15.6 minutes on lettuce in Kathmandu, Nepal.

Table-2: Flight activity patterns of *Apis cerana* and *Apis mellifera* on sarson bloom at different hours of the day, at Pallimore (No. of bees leaving the hive/minute)

Apis <i>cerana</i>	Time in											
	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800
\bar{X}	30.71	33.86	32.14	38.71	24.71	26.57	20.57	19.29	7.43	6.43	5.29	2.86
\pm S.E.	0.97	0.96	1.42	0.64	0.86	0.84	0.43	0.56	0.37	0.48	0.92	0.51
%	12.35	13.33	12.93	15.57	9.94	10.69	8.27	0.97	7.76	2.99	2.59	1.15
T	14.21	15.51	18.5	20.63	22.54	24.2	24.7	25.34	25.17	25.11	22.17	21.14
R.H.	74.71	77.28	71.57	72.86	64.57	59.43	59.57	53.86	52.86	55.71	74.71	70.28
<i>Apis mellifera</i>												
\bar{X}	34.57	45.43	39.14	43.14	40.00	44.43	41.00	30.00	21.29	7.57	4.86	1.57
\pm S.E.	1.32	0.84	0.51	0.94	0.31	0.99	0.69	0.79	0.42	0.42	0.51	0.20
%	9.79	12.86	11.09	12.22	11.33	12.59	11.61	8.50	6.03	2.14	1.38	0.44
T	14.21	15.51	18.5	20.63	22.54	24.2	24.7	25.34	25.17	25.11	22.17	21.14
R.H.	74.71	77.28	71.57	72.86	64.57	59.43	59.57	53.86	52.86	55.71	74.71	70.28

% = percentage; T = Temperature; R.H. = Relative humidity;
Peak foraging activity: 1000-1200 hours in *A. cerana*; 0800-1400 hours in *A. mellifera*

Fig. 1 : Flight activity patterns of *Apis cerana* and *Apis mellifera* in relation to sarson bloom at different hours of the day at Pallimore, Kathua.

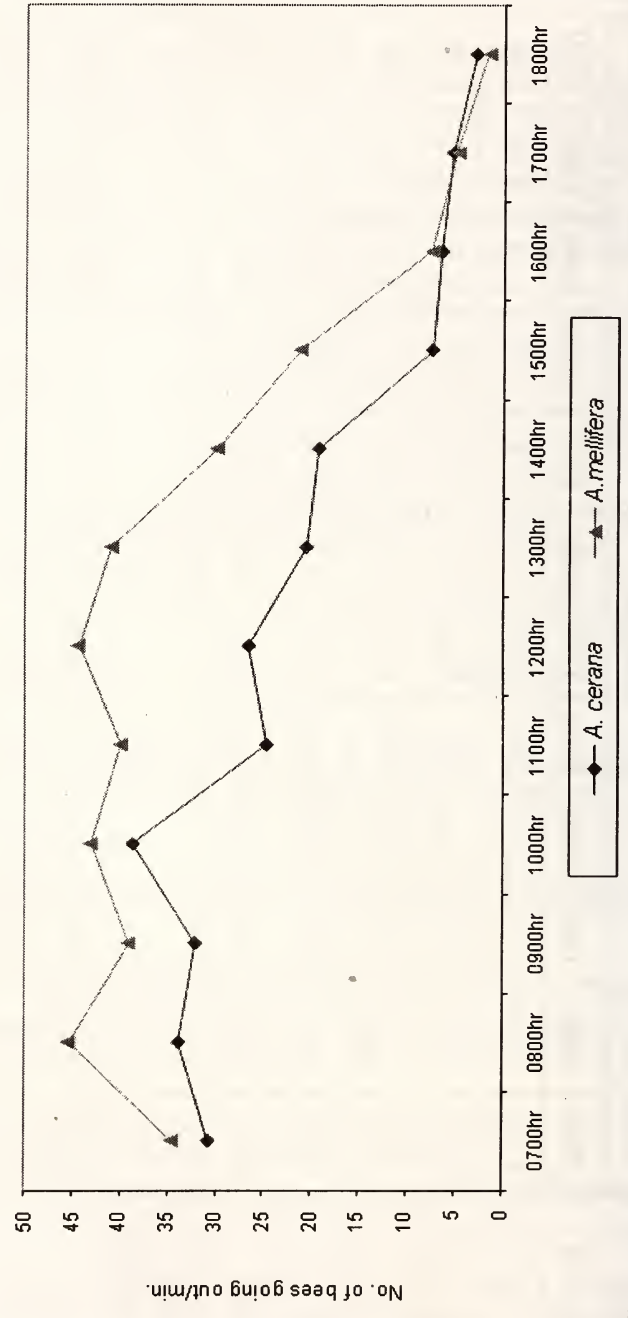
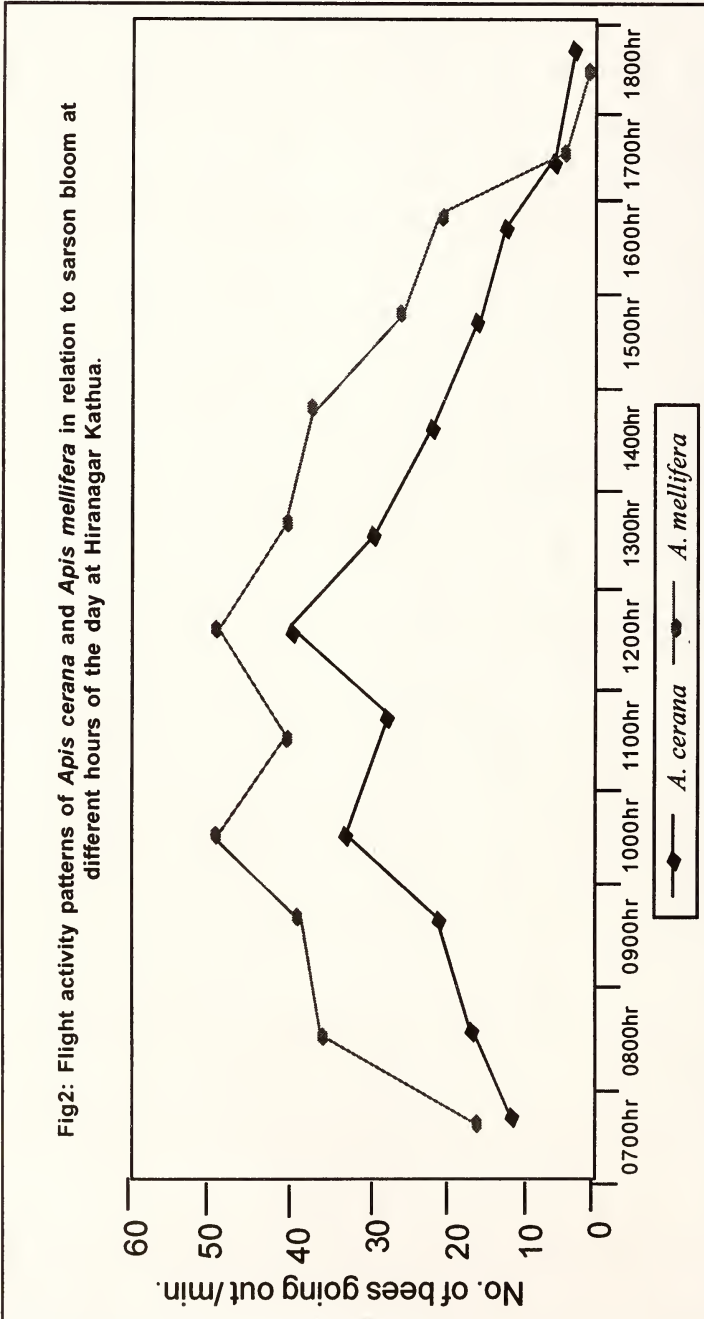


Table 3: Flight activity patterns of *Apis cerana* and *Apis mellifera* on sarson bloom at different hours of the day, at Hiranagar (No. of bees leaving the hive/minute)

<i>Apis cerana</i>	Time in											
	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800
\bar{X}	13.57	17.29	21.86	33.29	30.14	40.43	32.14	22.71	17.57	15.00	5.71	3.29
\pm S.E.	0.57	0.97	0.86	1.23	0.80	1.13	1.35	1.08	1.25	0.82	0.56	0.29
%	5.36	6.83	8.64	13.16	11.91	15.98	12.70	8.98	6.94	5.93	2.26	1.30
T	14.36	15.63	18.36	19.57	21.68	23.4	24.46	25.06	25.17	24.64	22.16	21.00
R.H.	73.14	75.57	68.00	78.43	68.43	63.93	60.71	53.43	53.1	53.57	72.14	68.43
<i>Apis mellifera</i>												
\bar{X}	17.43	38.29	40.43	51.00	41.43	53.14	42.86	38.86	25.43	20.71	4.71	1.29
\pm S.E.	0.65	0.68	1.32	0.93	0.97	2.16	0.74	0.59	1.46	0.61	0.36	0.18
%	4.64	10.19	10.76	13.58	11.03	14.15	11.41	10.35	6.77	5.51	1.25	0.34
T	14.36	15.63	18.36	19.57	21.68	23.4	24.46	25.06	25.17	24.64	22.16	21.00
R.H.	73.14	75.57	68.00	78.43	68.43	63.93	60.71	53.43	53.1	53.57	72.14	68.43

% = percentage; T = Temperature; R.H. = Relative humidity;

Peak foraging activity: 1000-1300 hours in *A. cerana*; 1000-1400 hours in *A. mellifera*



These variations in results may be because of different foraging efficiencies of these two species of honeybees in relation to morphology of different flowers.

Conclusion

It has been concluded that by placing both the colonies of bees (*A. cerana* and *A. mellifera*) in the fields of *B. campestris*, increases the peak period of pollination, hence enhances the yields of the crop.

Acknowledgements:

I owe my special thanks to Dr. V.K.Mattu, Department of Bioscience, H.P. University, Shimla and Dr. V.V. Ramamurty, Principal Scientist, Entomology Division, IARI, New Delhi for their immense support.

References

- Chand, H., Singh, R. and Hameed, S.F. 1994. Population dynamics of honey bees and insect pollinators on Indian mustard, *Brassica juncea* L. *Journal of Entomological Research* 18(3): 233-239.
- Dhaliwal, H.S. and Bhalla, O.P. 1980. On the foraging ecology of *Apis Cerana indica* F. *Proceeding of the second International Conference on Apiculture in Tropical Climates*, New Delhi, India: 71
- Kapoor, K.S. and Dhaliwal, H.S. 1989. Comparative foraging strategies of *Apis cerana indica* Fab. and *A. mellifera* L. on cauli flower *Indian Bee Journal* 51: 99-101
- Kumar, L. 1998. Foraging ecology and behaviour of *Apis cerana* F. and *A. mellifera* L. in pollinating apple and cherry flowers. Ph.D. Thesis. Himachal Pradesh University, Shimla, India.
- Mattu, V.K. 1982. Morphometric and behavioural studies on Indian honeybee (*Apis cerana indica* F.). Ph.D. Thesis. Himachal Pradesh University, Shimla, India.
- Mishra, R.C., Kumar, J. and Gupta, J.K. 1988. The effect of mode of pollination on yield and oil potential of *Brassica campestris* L. var. sarson with observations *Indian Bee Journal* 51: 99-101.
- Priti and Sihag, R.C. 1997. Diversity, visitation frequency, foraging behaviour and pollinating efficiency of insect pollinators visiting cauliflower (*Brassica oleracea* L. var. botrytis cv. Hazipur Local) blossoms. *Indian Bee Journal* 59(4): 230-237.
- Sihag, R.C. 1990. Seasonal management of honeybee (*Apis mellifera* L.) colonies in Haryana (India). *Indian Bee Journal* 52(1-4): 51-56.
- Thakur, A.K., Sharma, O.P., Garg, R. and Dogra, G.S. 1982. Comparative studies on foraging behaviour of *Apis mellifera* and *Apis cerana indica* on mustard. *Indian Bee Journal* 44 (4): 91-92.
- Verma, L.R. and Dulta, P.C. 1986. Foraging behaviour of *Apis cerana indica* and *Apis mellifera* in pollinating apple flowers. *Journal of Apicultural Research* 25: 197-201.
- Verma, L.R. and Partap, U. 1993. The Asian Hive Bee, *Apis cerana*, as a Pollinator in Vegetable Seed Production (An Awareness Handbook). International Centre for Integrated Mountain Development (ICIMOD), Kathmandu, Nepal.
- Wells, H. and Wells, P.H. 1983. Honeybee foraging: optimal diet, minimal uncertainty or individual constancy behaviour. *Journal of Animal Ecology* 52: 829-836.
- Waser, N.M. 1986. Flower constancy: definition, cause and measurement. *American Naturalist* 127 (5): 593-603.